MMS Study 2000-052

EXECUTIVE SUMMARY

Environmental Survey Of Potential Sand Resource Sites: Offshore New Jersey

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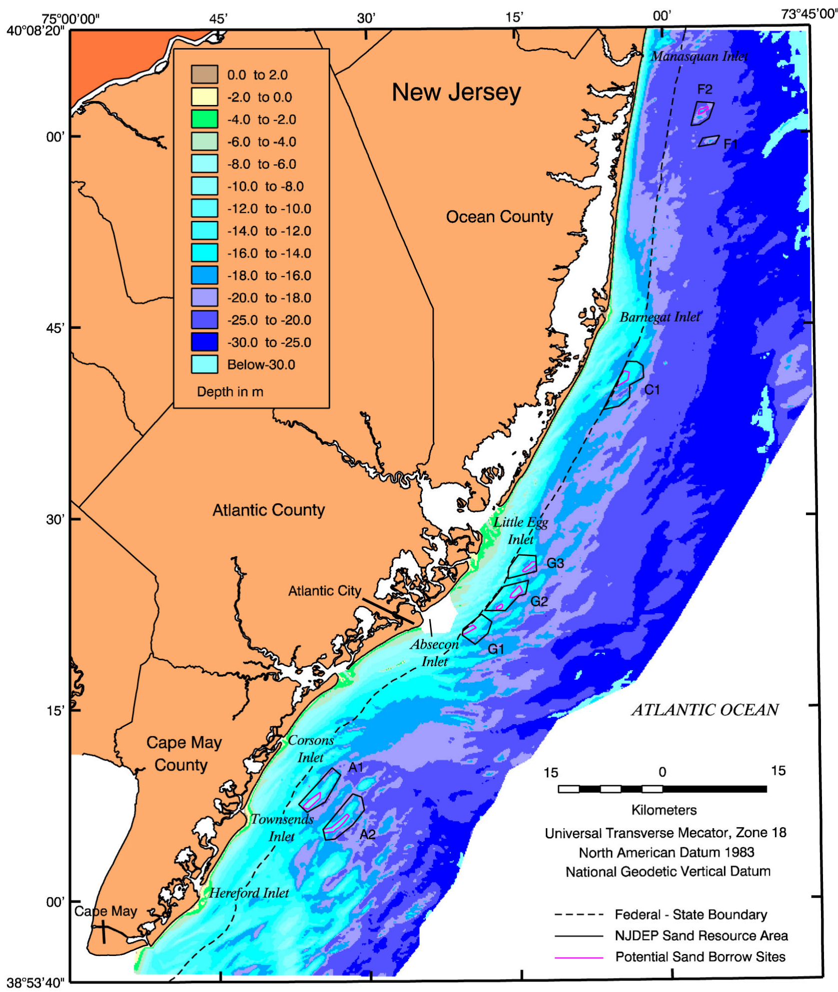

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July 2001

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INTRODUCTION

In recent years, there has been increasing interest in sand and gravel mining on the Outer Continental Shelf (OCS). The U.S. Minerals Management Service (MMS) has significant responsibilities with respect to the potential environmental impacts of sand and gravel mining. Existing regulations governing sand and gravel mining provide a framework for comprehensive environmental protection during operations. Guidelines for protecting the environment stem from a wide variety of laws, including the OCS Lands Act (OCSLA), National Environmental Policy Act (NEPA), Endangered Species Act, Marine Mammal Protection Act, and others. Regulations require activities to be conducted in a manner which prevents or minimizes the likelihood of any occurrences that may cause damage to the environment.

Currently, eight Federal-State task forces, several cooperative agreements, at least five negotiated agreements, and six environmental surveys exist to ensure substantive government and public involvement and attention to Federal, State, and local concerns regarding leasing, engineering, economic, and environmental aspects of sand and gravel mining (to obtain specific information regarding these activities, visit http://www.mms.gov/intermar/marineac.htm). Under the OCSLA, the MMS is required to conduct environmental studies to obtain information useful for decisions related to negotiated agreements and lease activities.

To this end, the MMS has initiated environmental studies along the U.S. Atlantic and Gulf coasts to provide information for programmatic marine mining decisions at MMS Headquarters and OCS Regional Offices. The report discussed in this Executive Summary presents results from one of the environmental studies administered through the MMS International Activities and Marine Minerals Division (INTERMAR). Entitled "Environmental Survey Of Potential Sand Resource Sites: Offshore New Jersey", this program was initiated by Aubrey Consulting, Inc. (ACI) in April 1997 under MMS Contract No. 14-35-01-97-CT-30864. The Final Report was prepared by Applied Coastal Research and Engineering, Inc. (Applied Coastal) in cooperation with Continental Shelf Associates, Inc. (CSA), ACI, and Barry A. Vittor & Associates, Inc. (BVA), and is cited as:

Byrnes, M.R., R.M. Hammer, B.A. Vittor, J.S. Ramsey, D.B. Snyder, J.D. Wood, K.F. Bosma, T.D. Thibaut, N.W. Phillips, 2000. Environmental Survey of Potential Sand Resource Sites: Offshore New Jersey. U.S. Department of the Interior, Minerals Management Service, International Activities and Marine Minerals Division (INTERMAR), Herndon, VA. OCS Report MMS 2000-052, Volume I: Main Text 380 pp. + Volume II: Appendices 291 pp.

STUDY AREA

The inshore portion of the continental shelf, seaward of the Federal-State OCS boundary and within the New Jersey Exclusive Economic Zone (EEZ), encompasses the project study area (Figure 1). The seaward limit of the study area is generally within about 20 km of the shoreline. Sand resource areas are located on the New Jersey OCS between the 10- and 20-m depth contours. The continental shelf surface within the study area contains many first-, second-, and third-order morphologic features formed during the Holocene transgression. Sand ridges 2- to 5-m high and 0.5- to 1.5-km apart represent second-order features that are the primary sand resource targets of this study.

Eight potential sand resource areas were defined within the study area through a Federal-State cooperative agreement between MMS-INTERMAR and the New Jersey Geological Survey (NJGS). For this study, seven borrow sites within Sand Resource Areas A1, A2, G1, G2, G3, C1, and F2 were defined to evaluate potential impacts of sand mining for beach replenishment. Sand Resource Area F1 was not included in the physical processes analysis because the quantity of sand available for beach nourishment is small (<1 million cubic meters

[MCM]) relative to basic replenishment needs, and water depths are greatest in this region, making potential dredging operations more complicated and costly.

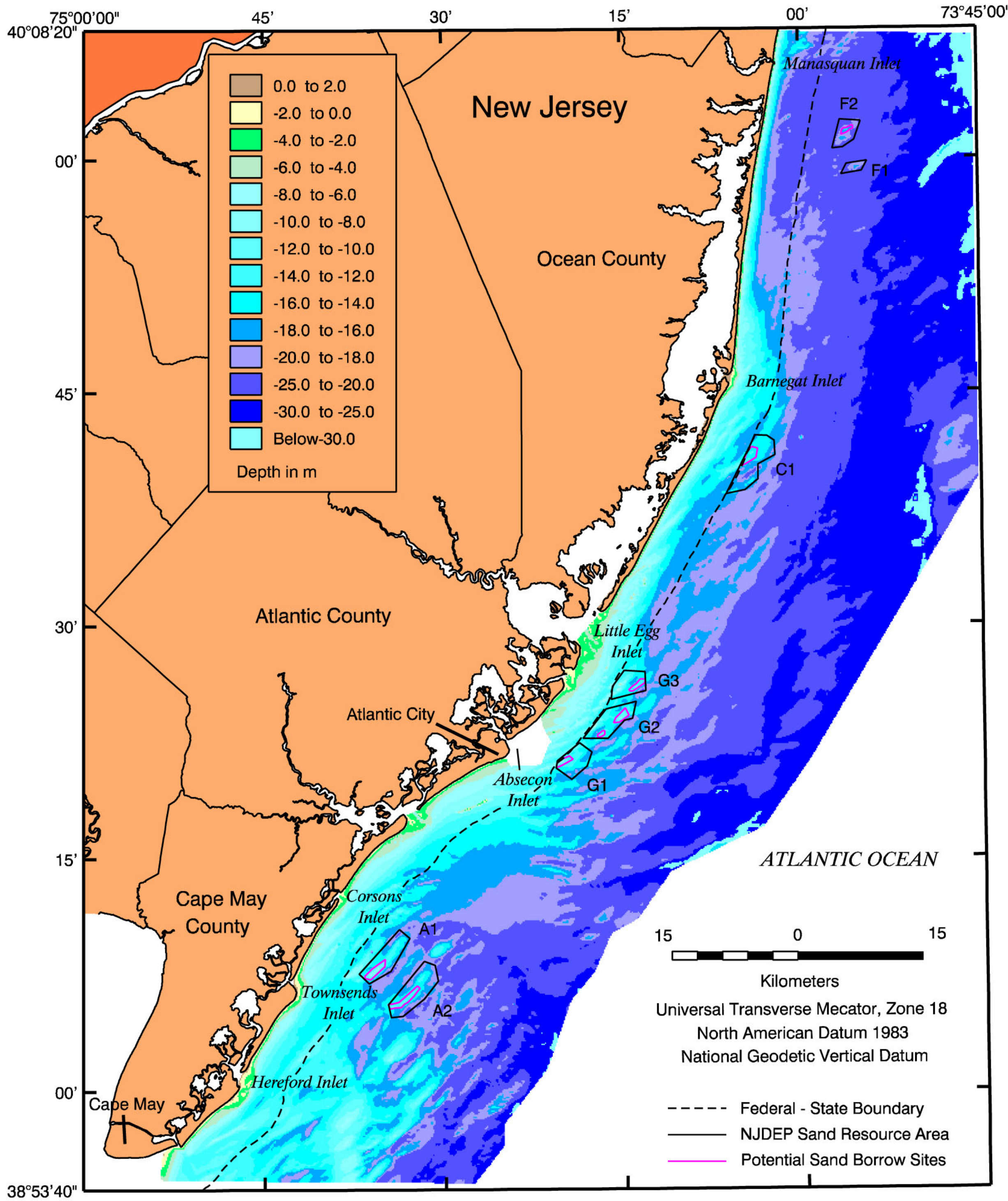

Figure 1. Location of New Jersey study area and potential sand resource areas.

STUDY PURPOSE

The primary purpose of this study was to address environmental concerns raised by the potential for dredging sand from the OCS offshore the State of New Jersey for beach replenishment and to document the findings in a technical report. The primary environmental concerns focused on physical and biological components of the environment. To this end, seven study objectives were identified:

- Compile and analyze existing oceanographic literature and data sets to develop an understanding of environmental conditions offshore New Jersey and the ramifications of dredging operations at selected sand borrow sites;
- Design and conduct biological field data collection efforts to supplement existing information;
- Analyze physical and biological data sets to address basic environmental concerns regarding potential sand dredging operations;
- Use physical processes data sets and wave climate simulations to predict wave transformation under natural conditions and in the presence of proposed dredging activities;
- Determine existing coastal and nearshore sediment transport patterns using historical data sets, and predict future changes resulting from proposed sand dredging operations;
- Evaluate the potential environmental effects of multiple dredging scenarios; and
- Develop a document summarizing the information generated to assist with decisions concerning preparation of an Environmental Assessment/Impact Statement to support a negotiated agreement.

In meeting these objectives, the Final Report provides valuable information regarding environmental concerns examined relative to proposed future sand dredging offshore New Jersey in support of beach replenishment needs. This Executive Summary highlights conclusions of the study relative to project objectives.

SUMMARY AND CONCLUSIONS

Physical and biological processes at selected sand resource areas offshore New Jersey were evaluated to address environmental concerns raised by the potential for dredging sand from the OCS for beach replenishment. Wave transformation and sediment transport numerical modeling were employed to simulate the physical environmental effects of proposed sand dredging operations to ensure that offshore sand resources are developed in an environmentally sound manner. Biological data were collected and analyzed to assess the potential impacts of offshore dredging activities to benthic and pelagic communities within the study area to minimize or preclude long-term adverse environmental impacts.

The following discussion provides a summary of results and conclusions regarding the potential environmental effects of sand mining on the OCS for replenishing sand to eroding beaches. Because benthic and pelagic biological characteristics are in part determined by spatially varying physical processes throughout the study area, physical processes analyses are summarized first.

Wave Transformation Numerical Modeling

A primary component of any physical environmental effects analysis related to sand mining from the OCS must include numerical wave transformation modeling. Potentially rapid and significant changes in bathymetry due to sand extraction on the OCS may have substantial impact on wave propagation patterns on the continental shelf and at the shoreline. In turn, sediment transport patterns may be altered so as to adversely impact beach erosion or accretion problems. As such, substantial effort was spent understanding existing wave propagation patterns relative to those resulting from potential sand extraction scenarios.

The spectral wave transformation model REF/DIF S was used to evaluate changes in wave approach resulting from potential sand dredging activities. REF/DIF S is a combined refraction and diffraction spectral wave model, which can simulate the behavior of a random sea and incorporates the effects of shoaling, wave breaking, refraction, diffraction, and energy dissipation. A spectral wave model was selected to simulate wave transformation because of its ability to propagate realistic wave components (a spectrum) simultaneously across the continental shelf surface. By simulating several wave components together, a spectral wave model represents nature more closely.

Wave transformation results identify key areas of wave convergence, wave divergence, and shadow zones offshore New Jersey. Non-storm significant wave heights and wave angles experience little variation to the 20-m depth contour where the wave field begins to feel the influence of bathymetry. The region offshore Townsends and Corsons Inlets (Areas A1 and A2) has a relatively consistent longshore wave height distribution. Several areas of wave convergence and divergence were caused by the shoals surrounding Sand Resource Areas A1 and A2. These features focus wave energy at various locations along the coast depending on wave approach direction. Offshore Little Egg and Brigantine Inlets (Areas G1, G2, and G3), wave transformation again is influenced by numerous linear ridges. Increased wave heights appear most frequently near Brigantine Inlet. The area to the south of Barnegat Inlet (Area C1) experiences mild shoreline retreat and a consistent wave height distribution along the shoreline. Shoals and depressions south of Area C1, as well as offshore linear ridges to the north, can produce significant wave transformation within the modeling domain. Wave energy focused by these features most often impact the Harvey Cedars and Loveladies regions. The area seaward of northern Barnegat Bay (Area F2) also experiences wave height changes produced by offshore shoals and depressions within the modeling domain. Consistent wave focusing is observed by the shoal within Area F2, as well as the shoals to the south and southeast of F2. Wave energy focused by these features may impact regions from Seaside Park north to Bay Head, depending on approach direction.

For the 50-yr hurricane and northeast storm, wave patterns are similar to the directional approach results. An increase in wave height is documented in many areas where wave convergence occurs. For example, the shoal present in Area F2 produces wave convergence that results in 6.0 m wave heights during a typical 50-yr northeast storm. The 50-yr hurricane and northeast storm simulated in the present study represents a major storm that could have impact on the approaching wave field and sediment transport patterns.

Differences in wave height between pre- and post-dredging scenarios offshore New Jersey indicate maximum wave height changes for directional approach simulations ranging from 0.1 to 0.25 m (7 to 16% of the initial wave height). The magnitude of modifications increase as the magnitude of waves increase or when the orientation of potential borrow sites aligns with waves to produce maximum impact (e.g., southeast approach at Grid A). In Grids A and B2, which are the southernmost grids, maximum wave height changes dissipate relatively quickly as waves advance towards the coast and break. In Grids B1 and C, maximum changes do not dissipate as readily. At potential impact areas along the coast, wave height changes average ±0.13, ±0.11, ±0.15, and ±0.10 m for Grids A, B1, B2, and C, respectively. These modifications represent changes of approximately ±3 to 15% when compared with wave heights for existing conditions. Overall, there is minimal to no impact caused by potential offshore dredging during normal conditions.

During extreme wave conditions (e.g., a 50-yr storm), wave heights are increased from 0.4 to 1.4 m, suggesting a rather significant change. However, as a result of the increased magnitude of the incoming waves, this generally represents a change of less than 10%. Due to the orientation of the shoreline and the proposed borrow sites, a hurricane has more significant impacts on Grids A and B2 (Areas A1, A2, G1, G2, and G3), while a northeast storm more significantly impacts Grids B1 and C (Areas C1 and F2). For most of the sand borrow sites, a significant amount of wave energy is dissipated before waves reach the coast, especially for Grids A and B2. As such, wave height increases are less than 0.4 m along most of the coast. A maximum change of 0.4 m in wave height is not expected to increase nearshore erosion above existing conditions during a storm event.

Borrow sites within Areas A1 and A2, located offshore of Townsends Inlet, have a greater impact on the wave field due to larger extraction volumes (8.8 and 8.6 MCM, respectively). In addition, regions with multiple borrow sites (Grids A and B2) indicate a greater potential for wave modifications with simultaneous dredging. Overall, wave transformation impacted by potential borrow sites is minimal during normal and storm conditions.

Circulation and Sediment Transport Dynamics

Current measurements and analyses, and wave transformation modeling, provide baseline information on incident processes impacting coastal environments under existing conditions and with respect to proposed sand mining activities for beach replenishment. Ultimately, the most important data set for understanding physical processes impacts from offshore sand extraction is changes in sediment transport dynamics resulting from potential sand extraction scenarios relative to existing conditions.

While no large-scale predictive circulation models were developed to quantify the effects of dredging in sand resource areas, the analysis of current patterns resulting from this study suggests proposed sand mining will have negligible impact on large-scale shelf circulation. Measurement of bottom currents offshore New Jersey (seaward of Little Egg Inlet) throughout an approximate two-year period (1993 to 1995) revealed considerable variability in flow speed and direction. The mean flow was to the southwest along the inner shelf bathymetric contours. Strongest flow was observed in the along-shelf direction, with peak velocities of nearly 50 cm/sec (1 knot) to the south; maximum northward currents reached 37 cm/sec. Flow reversals were noted frequently.

In the cross-shelf direction, mean flow was oriented onshore, consistent with upwelling processes that push bottom waters up onto the shelf. Maximum cross-shelf flow was 31 cm/sec (directed onshore); minimum flow was -13 cm/sec (directed offshore). Cross-shelf bottom currents were affected most significantly by semi-diurnal tides, with a mean onshore flow. Wind-driven currents were found to be less significant in the cross-shelf direction. Seasonal variability was most significant for wind-driven currents. Winter and autumn data records were most energetic, with summer and spring data sets possessing smaller energy values.

These data suggest that along-shelf currents possess higher energy than cross-shelf flows. Along-shelf currents were dominated by wind-driven processes, accounting for as much as 70% of the total current energy. Wind-driven processes were greatest in winter; however, wind-driven flows appeared strongly biased by singular events, such as local responses to storm winds or non-locally generated free waves that influenced the magnitude of wind-driven current energy. This evidence suggests that these singular events, with corresponding higher currents, have the greatest potential to transport sand. If so, sediment transport patterns are predominately in the along-shelf direction, with a net transport oriented in the direction of the mean southerly flow. The data also show that singular events had little impact on cross-shelf currents, indicating that cross-shelf sediment transport due to currents is weak. Because proposed sand mining locations are small relative to the entire shelf area, it is anticipated that proposed dredging will not remove enough material to significantly alter major bathymetric features in the region. Therefore, the forces and geometric features that principally affect circulation patterns will remain relatively unchanged.

Three independent sediment transport analyses were completed to evaluate physical environmental impacts due to sand mining. First, historical sediment transport trends were quantified to document regional, long-term sediment movement throughout the study area using historical bathymetric data. Erosion and accretion patterns were documented, and sediment transport rates in the littoral zone and at offshore borrow sites were evaluated to assess potential changes due to offshore sand dredging activities. Second, sediment transport patterns at proposed offshore borrow sites were evaluated using wave modeling results and current measurements. Post-dredging wave model results were integrated with regional current measurements to estimate sediment transport trends for predicting borrow site infilling rates. Third, nearshore currents and sediment transport were modeled using wave transformation modeling output to estimate potential impacts to the longshore sand transport system (beach erosion and accretion). All three methods were compared for documenting consistency of measurements relative to predictions, and potential physical environmental impacts were identified.

Historical Sediment Transport Patterns

Regional geomorphic changes for the period 1843/91 to 1934/77 were analyzed to assess long-term, net coastal sediment dynamics. Although these data did not provide information on the potential impacts of sand dredging from proposed borrow sites, they do provide a means of calibrating predictive sediment transport models relative to infilling rates at borrow sites and longshore sand transport.

Shoreline position and nearshore bathymetric change document four important sediment transport trends. First, the predominant direction of transport throughout the study area is north to south. Southern Long Beach Island (north of Little Egg Inlet) and southern Island Beach (north of Barnegat Inlet) have migrated at a rate of about 14 m/yr to the south since 1839/42. The ebb-tidal shoals at all inlets in the study area are skewed to the south, and the channels are aligned in a northwest-southeast direction.

Second, the most dynamic features within the study area, in terms of nearshore sediment transport, are the ebb-tidal shoals associated with inlets along the southeastern barrier island chain. Areas of significant erosion and accretion are documented for the period 1843/91 to 1934/77, reflecting wave and current dynamics at entrances, the influence of engineering structures on morphologic change, and the contribution of littoral sand transport from the north to sediment bypassing and shoal migration.

Third, alternating bands of erosion and accretion on the continental shelf east of the Federal-State boundary illustrate relatively slow but steady reworking of the upper shelf surface as sand ridges migrate from north to south. The process by which this is occurring at Areas G1, G2, and G3 suggests that a borrow site in this region would fill with sand transported from an adjacent site at a rate of about 62,000 to 125,000 m^3/yr. At Areas A1 and A2, the potential sand transport rate increases to 160,000 to 200,000 m^3/yr. This increase in potential transport rate reflects a more dynamic offshore environment seaward of the southern barrier island chain.

Finally, net longshore transport rates determined from seafloor changes in the littoral zone between Little Egg Inlet and the beach south of Hereford Inlet indicate an increasing transport rate to the south from about 70,000 m^3/yr south of Little Egg Inlet to 190,000 to 230,000 m^3/yr at Townsends and Hereford Inlets. It appears that areas of largest net transport exist just south of entrances as a result of natural sediment bypassing from updrift to downdrift barrier beaches. These rates compare well and provide a measured level of confidence in wave and sediment transport modeling predictions relative to impacts associated with sand dredging from proposed borrow sites.

Sediment Transport at Potential Borrow Sites

In addition to predicted modifications to the wave field, potential sand mining at offshore borrow sites results in minor changes in sediment transport pathways in and around the dredged regions. The modifications to bathymetry caused by sand mining only influence local hydrodynamic and sediment transport processes in the offshore area. Although wave heights may change at the dredged borrow sites, areas adjacent to the sites do not experience dramatic changes in wave or sediment transport characteristics.

Initially, sediment transport at borrow sites will experience rapid changes after sand dredging is complete. Given the water depths at the proposed borrow sites, it is expected that minimal impacts to waves and regional sediment transport processes will occur during infilling. Sediment that replaces the dredged material will fluctuate based on location, time of dredging, and storm characteristics following dredging episodes. Average transport rates range from a minimum of 28 m^3/day (about 10,000 m^3/yr; Area F2) to a high of 450 m^3/day (about 164,000 m^3/yr; Area A1), while the infilling rate varies between 54 (Area A1) to 303 years (Area C1). This range of infilling times is based on the volume of sand numerically dredged from a borrow site as well as the sediment transport rate. Predicted nearshore sediment transport rates are slightly lower than those determined from historical data sets, but the two rate estimates are within the same order of magnitude (10,000 to 160,000 m^3/yr versus 62,000 to 200,000 m^3/yr, respectively). Calculated infilling times would be reduced if storm events were incorporated into the analysis.

Nearshore Sediment Transport Modeling

The potential effects of offshore sand mining on nearshore sediment transport patterns are of interest because dredged holes can intensify wave energy at the shoreline and create erosional hot-spots. Sand dredging impacts for Areas A1 and A2 illustrate that there is a defined, but minor, change in littoral transport. Due to relatively high transport rates along the southern portion of the New Jersey coast, the percent difference in transport rates associated with dredging was smallest within this area (the maximum variation in annual longshore sand transport rate was approximately 7% of the existing value). The shadow zones landward of Areas A1 and A2 are located approximately 5 km and 1 km north of Townsends Inlet, respectively. These shadow zones are indicated by a significant reduction in south-directed wave energy. Likewise, the largest increase in south-directed transport occurs between the shadow zones (3 km north of Townsends Inlet), where both borrow sites in Areas A1 and A2 have wave energy refracted to the south and north, respectively. This increase in wave energy at the shoreline is responsible for the increased south-directed transport between the shadow zones.

Because the offshore distance to Resource Areas G2 and G3 is relatively small (approximately 5 km offshore), the region of potential impacts is more confined than the area defined for Area A2. For the borrow sites in Areas G2 and G3, the maximum variation in annual longshore sand transport rate is approximately 9% of the existing value. Only a single shadow zone landward of Resource Areas G2 and G3 exists approximately 1 km south of Brigantine Inlet. This shadow zone is indicated by a significant reduction in south-directed wave energy. The largest increase in south-directed transport occurs south of the shadow zone (approximately 2 km south of Brigantine Inlet). However, it is unclear whether the shadow zone or the region of increased south-directed wave energy are a result of dredging in Areas G2 (one potential borrow site), G3 (two potential borrow sites), or a combination of the three potential borrow sites.

For Resource Area C1, the combined effect of various wave conditions tends to mute the increase in south-directed sediment transport, where the largest increase is approximately 3,000 m^3/yr. Although the maximum variation in annual longshore sand transport rate is approximately 20% of the existing average value, the relatively high percentage of the 45,000 m^3/yr net transport indicates similar impacts as those predicted for Areas A and G. A series of shadow zones landward of Area C1 occurs as a result of wave refraction generated by the series of wave conditions modeled. The largest shadow zone exists at approximately UTM Northing coordinate 4,394,000 m due to waves propagating from the east. In addition to this shadow zone, waves propagating from the east-southeast cause a reduction in the south-directed transport at UTM Northing coordinate 4,396,000 m, and waves propagating from the southeast cause a shadow zone at UTM Northing coordinate 4,398,500 m.

For the borrow site in Area F2, the maximum variation in annual longshore sand transport rate is approximately 17% of the existing value. Similar to Grid B1, the relatively low net sediment transport indicates a high percentage of impact to the transport rate; however, the maximum change of approximately 12,700 m^3/yr is similar to the modeled change for Grids A, B2, and B1. The shadow zone landward of Area F2 is located approximately 6 km south of Manasquan Inlet. Likewise, the largest increase in north-directed transport occurs to either side of the shadow zone (approximately 4 and 8 km south of Manasquan Inlet, respectively). This increase in wave energy at the shoreline is responsible for the increased north-directed transport both north and south of the primary shadow zone.

For average annual conditions, mean longshore sand transport rates were approximately equal landward of borrow sites in resource areas along the New Jersey coast. The absolute value of the mean difference between existing and post-dredging conditions was relatively consistent, ranging between 9,000 (20.0%) and 14,900 m^3/yr (7.2%) along the New Jersey shoreline. Although the percent difference computed for the northern two grids (Grids B1 and C) was larger than that calculated farther south, this trend is a result of the low relative net transport rates along the northern beaches rather than an increase in impacts associated with dredging.

Benthic Environment

Results of the May and September 1998 biological field surveys agree well with previous descriptions concerning benthic assemblages associated with shallow shelf habitats offshore New Jersey. Benthic assemblages surveyed from the proposed sand resource areas consisted of members of the major invertebrate and vertebrate groups commonly found in the study area. Numerically dominant infaunal groups included numerous crustaceans, echinoderms, molluscans, and polychaetes, while epifaunal taxa consisted primarily of decapod crustaceans, sand dollars, moon snails, and squid. Biological surveys of the sand resource areas support the findings of numerous investigations in the region that have found strong associations of infaunal taxa with particular sedimentary habitats. Canonical correlation analysis indicated that the composition of benthic assemblages inhabiting New Jersey resource area stations was affected mostly by the percentage of gravel composition of surficial sediments. Infaunal assemblage distributions reflected sediment type distributions. Trough and sand ridge features further contributed to the prominent spatial variability exhibited by benthic assemblages in the sand resource areas. Temporal differences in infaunal assemblages were apparent as well. Nearly half of the infaunal taxa sampled over the entire project were included in both the May and September surveys; however, most (68%) of the remainder of censused taxa were collected only during the September cruise. Also, overall infaunal abundance was higher during the May survey than was observed in September. Both the number of epifaunal taxa and overall epifaunal abundance were greater in September as compared to the May survey, as well, and this temporal abundance pattern also is characteristic of the study area.

Numerically dominant fishes collected during the 1998 sand resource area surveys are typical components of demersal assemblages in the study area. Fishes such as bay anchovy (*Anchoa mitchilli*), clearnose skate (*Raja eglanteria*), northern searobin (*Prionotus carolinus*), scup (*Stenotomus chrysops*), and windowpane (*Scophthalmus aquosus*) were numerical dominants during the 1998 biological surveys and these species consistently are among the most ubiquitous and abundant demersal taxa in the region. Despite inherent spatial and temporal heterogeneity in the distribution and abundance of demersal fishes and low numbers in trawls, results of the 1998 surveys of the sand resource areas generally are consistent with results of historical demersal survey results in the region.

Potential benthic effects from dredging will result from sediment removal, suspension/dispersion, and deposition. Primary effects to infaunal populations will be through removal of individuals along with sediments. Effects are expected to be short-term and localized. Seasonality and recruitment patterns indicate that removal of sand between late fall and early spring would result in less stress on benthic populations. Early stage succession will begin within days of sand removal, through settlement of larval recruits, primarily annelids and bivalves. Initial larval recruitment will be by the opportunistic taxa that were numerical dominants in trough areas during the biological surveys (e.g., the polychaete *Asabellides oculata* and bivalves *Nucula proxima* and *Tellina agilis*). These species are well adapted to environmental stress and exploit suitable habitat when it becomes available. Later successional stages of benthic recolonization will be more gradual, involving taxa that generally are less opportunistic and longer lived. Immigration of motile annelids, crustaceans, and echinoderms into impacted areas also will begin soon after excavation.

While community composition may differ for a period of time after the last dredging, the infaunal assemblage type that exists in mined areas will be similar to naturally occurring assemblages in the study area, particularly those assemblages inhabiting inter-ridge troughs. Based on previous observations of infaunal reestablishment in dredged areas, the infaunal community in dredged sites within sand resource areas most likely will become reestablished within 2 years, exhibiting levels of infaunal abundance, diversity, and composition comparable to nearby non-dredged areas. Given that the expected beach replenishment interval is on the order of a decade, and that the expected recovery time of the affected benthic community after sand removal is anticipated to be much less than that, the potential for significant cumulative benthic impacts is remote.

Atlantic surfclam is the most economically important benthic species found in or around the sand resource areas. National Marine Fisheries Service data indicate that the likelihood of encountering Atlantic surfclams in any of the New Jersey sand resource areas is reasonably high. Primary effects of dredging on Atlantic surfclam would be entrainment, hypoxia/anoxia, and turbidity. Project scheduling would not be useful for avoiding dredging-induced impacts to

Atlantic surfclams. Once an exact borrow site is chosen for dredging, a commercial clam fisher should be hired to evaluate the site for the presence and abundance of Atlantic surfclams. If commercial quantities are found, then the fisher should harvest them from the site prior to dredging. This approach would remove individuals that would be subject to impacts. Studies have demonstrated that juvenile Atlantic surfclams will recruit to dredged borrow sites.

Pelagic Environment

Zooplankton, squids, fishes, sea turtles, and marine mammals were groups in the pelagic environment considered to be potentially affected by offshore dredging. No cumulative effects to any of these groups are expected from multiple sand mining operations. Zooplankters could be affected by entrainment and turbidity. Considering the high reproductive capacity of zooplankton along with the relatively small area of the dredge suction field and the volume of water entrained compared to the overall volume of surrounding waters, it is unlikely that entrainment or turbidity would greatly affect zooplankton populations or assemblages in the New Jersey sand resource areas. If borrow sites are used in Areas G1, G2, or G3, an environmental window excluding summer and fall months could be considered to avoid dredging when fish juveniles and larvae are most prevalent, but only if additional data become available to determine the extent of impacts and justify the restriction.

Squids could be entrained if they encountered the suction field of a hydraulic dredge. In addition, squid eggs are laid in large clusters on the seafloor and could be removed with sediments. Dredging is unlikely to significantly impact squid populations in the vicinity of the sand resource areas. This precludes the need for an environmental window or specific project scheduling to protect squid resources.

Dredging should not present a significant problem for pelagic fishes offshore of New Jersey. Potential effects to fishes could occur through entrainment, attraction, and turbidity. If an environmental window is sought to protect pelagic fishes from dredging impacts, the spring to fall period would encompass the peak seasons for the economically important species. Quantitative data are lacking to support the use of an environmental window to lessen effects on pelagic fishes.

Essential Fish Habitat for several fish species (and life stages) overlap the eight sand resource areas offshore New Jersey. The area encompassed by the eight sand resource areas is very small relative to the mapped EFH characteristics. For this reason, the effect of dredging on EFH for the managed species is expected to be minimal.

The main potential effect of dredging on sea turtles is physical injury or death caused by the suction and/or cutting action of the dredge head. No significant effects on turtles are expected from turbidity, anoxia, or noise. Three sea turtle species that typically occur off New Jersey (loggerhead, green, and Kemp's ridley) are considered to be at risk because of their benthic feeding habits. Loggerheads are the most abundant turtles in the project area, and historically, they have been the species most frequently entrained during hopper dredging. If a hopper dredge is used, then it would be best to avoid the June through November turtle season. However, the vagaries of winter weather off New Jersey make it infeasible to prohibit dredging during these months. If use of a hopper dredge during this season cannot be avoided, then other mitigation and monitoring requirements may be appropriate, such as turtle monitoring and use of a turtle-deflecting draghead. If a cutterhead suction dredge is used, seasonal or other restrictions are considered unnecessary because there is little likelihood of killing or injuring sea turtles.

Marine mammal species occurring commonly on the shelf, such as bottlenose dolphin and common dolphin, may be present year-round but are unlikely to be adversely affected by dredging due to their agility. Harbor porpoise occurrence is more seasonal, but the likelihood of impact is so low that it does not warrant seasonal restrictions on dredging. Fin and humpback whales would be most likely to occur during winter or spring, and northern right whales as transients during spring and fall. There is no "resident" population of any of these whales in the study area; rather, they would be temporary inhabitants, or would be transiting the area during seasonal migrations. Generally, the probability of encountering these species in the project area would be lowest during summer. However, due to the low likelihood of impact, seasonal restrictions on dredging probably are not warranted. Instead, measures to minimize possible vessel interactions with these endangered species may be appropriate.

SYNTHESIS

The data collected, analyses performed, and numerical modeling conducted for this study indicate that proposed sand dredging at sites evaluated on the OCS offshore New Jersey should have minimal environmental impact on fluid and sediment dynamics and biological communities. Short-term impacts to benthic communities are expected due to the physical removal of borrow material, but the potential for significant cumulative benthic impacts is remote. Additionally, no cumulative effects to any of the pelagic groups are expected from potential sand mining operations.

Minimal physical environmental impacts due to potential sand dredging operations have been identified through wave and sediment transport simulations. However, under normal wave conditions, the average change in longshore sand transport is about 13% of existing conditions. Because wave and sediment transport predictions are only reliable to within about ±25 to 35%, predicted changes are not deemed significant. Although changes during storm conditions illustrate greater variation, the ability of models to predict storm wave transformation and resultant sediment transport is less certain. Because minor impacts to wave and sediment transport dynamics and biology may occur under conditions similar to those imposed in the present study, additional data collection and analysis may be required for a specific sand extraction scenario to determine the extent of impacts.